

**In the Drawings:**

Please replace the drawings as filed with the replacement drawings enclosed herewith which are labeled as "Replacement Sheet". No new matter has been added.

## **REMARKS**

The Office action dated April 7, 2006 is acknowledged. Claims 1-18 are pending in the instant application. According to the Office action, each of these claims has been rejected. Claims 1, 10 and 16 have been amended, as set forth above, to correct a few minor informalities. Reconsideration is respectfully requested in light of the amendments being made herein and of the following remarks. No new matter has been added.

### **Objection to the Drawings**

The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the reference numbers 102, 112. Replacement sheets are enclosed herewith which correct this matter. Withdrawal of this rejection is therefore respectfully requested. No new matter has been added.

The drawings are also objected to as failing to comply with 37 CFR 1.84(p)(4) because the reference character 108 has been used to designate both the hollow cylindrical passage and the stack fuel manifold. The applicants respectfully traverse this rejection on the basis that the hollow cylindrical passage and the stack fuel manifold are two different terms which refer to the same structure of the invention. The applicants refer to paragraph [000028] of the specification which reads, in part, as follows:

---A center cylinder 106 is located inside stack 102 and defines a hollow cylindrical passage (stack fuel manifold) 108 which is adapted to provide a fuel to electrochemical stack 102 from a fuel source.---

Therefore, withdrawal of this rejection is also respectfully requested.

### **Objection to the Specification**

The disclosure is objected to because the current status of the non-provisional parent application has not been updated. This issue has been corrected, as noted above.

The disclosure is also objected to because the specification in paragraph 000028 recites that Figure 2 shows adjacent cells 100 and 101, but that Figure 2 fails to do so. Paragraph [000028] has been amended accordingly, as set forth above. No new matter has been added. Withdrawal of the objections to the specification is respectfully requested.

### **Rejection of Claims 1-18 – Double Patenting**

Claims 1-18 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1-11 and 13-17 of U.S. Patent No. 6,811,913 (Ruhl) in view of U.S. Patent No. 6,365,293 (Isono, et al.). Submitted herewith is a terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) for overcoming the obviousness-type double patenting rejection, along with the terminal disclaimer fee set forth in 37 CFR 1.20(d). Withdrawal of the double patenting rejection is respectfully requested.

### **Rejection of Claims 1, 3-4, 10, 12 and 16-18 under Section 103(a)**

Claims 1, 3-4, 10, 12 and 16-18 have been rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 4,770,955 (Ruhl) in view of U.S. Patent No. 6,365,293 (Isono, et al.). The Examiner states that Ruhl discloses a solid electrolyte fuel cell assembly wherein the electrolyte is yttria-stabilized zirconia contacting the anode and the cathode. The Examiner essentially argues that Ruhl teaches every limitation of present

claims 1, 3-4, 10, 12 and 16-18, except for the specific tapered gas diffusion layer. The Examiner refers to Isono, et al. for the teaching of gas diffusivity being adjusted by changing the thickness of the gas diffusion layer. Moreover, the Examiner argues that the gas diffusivity is set relatively small by setting the thickness large in the entrance part and the gas diffusivity is set relatively large by setting the thickness small in the exit part.

In view of the above, the Examiner argues that it would have been obvious to one of ordinary skill in the art at the time the present invention was made to use the specific tapered gas diffusion layer of Isono, et al. in the fuel cell system of Ruhl for arriving at the present invention. Thus, the Examiner states that Isono, et al. readily envision to progressively change the thickness of the gas diffusion layer for the benefit of adjusting gas diffusivity.

The Examiner still further argues that Isono, et al. recognizes the thickness of the diffusion layer as a variable which achieves a recognized result, thus the specific thickness results from the characterization as routine experimentation of an optimum or workable range. In this regard, the Examiner notes that changes in shape is a matter of choice which a person of ordinary skill in the art would have found obvious absent persuasive evidence that the particular configuration of the claimed diffusion layer and cell is significant. Moreover, the Examiner notes that aesthetic design changes having no mechanical function cannot be relied upon to patentably distinguish the claimed invention from the prior art.

The applicants respectfully submit that to establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or

motivation to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. Third, the prior art reference (or references when combined) must teach or suggest all of the claim limitations (M.P.E.P. §2143). Moreover, a prior art reference must be considered in its entirety, i.e., as a whole (emphasis provided), including portions that would lead away from the claimed invention (M.P.E.P. §2141.02(VI)); *W.L. Gore & Associates, Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984).) The mere fact that references can (emphasis provided) be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination (M.P.E.P. §2143.01(III); *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990)). Still further, if the proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification (M.P.E.P. §2143.01(V); *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984)).

The Applicants respectfully submit that one skilled in the art would have no suggestion or motivation to combine the aforementioned references in order to arrive at the presently claimed invention. Additionally, even if one skilled in the art were to consider the combination of teachings of the aforementioned references, each and every limitation of the present invention would not be disclosed, nor would there be a reasonable expectation of success if the aforementioned references were to be considered alone, or in combination.

The combination of the cited references fails to teach every limitation of the

presently claimed invention. The system of the present invention includes two seals per cell (i.e., claims 1, 10, 17 and 18, each of which describe “a first annular seal” and “a second annular seal.”). The applicant submits that, regarding Ruhl ‘955, the reference fails to teach or disclose the feature that the fuel electrode or fuel diffusion layer have a seal disposed around them, i.e., on the outside the fuel electrode and fuel diffusion layer. Ruhl ‘955 discloses two embodiments of the system. The first, shown in Fig. 1, includes an anode 4 and a tubular gasket or seal 8 around the inner surface of the anode 4. A gasket or seal 7 is provided for forming a seal between the separator 2 and the electrolyte 6 (col. 2, lines 48-52; col. 3, lines 13-35). The gasket 8 is disposed between the separator and the electrolyte to form a substantially gas-tight seal (col. 3, lines 31-33). Moreover, gasket 8 forms part of the inside surface of tube 14 (emphasis added) (col. 3, line 33-34 and Fig. 1). This is clearly a different structure from the seal of the present invention, which, as set forth in claims 1, 10 and 17, includes the seal disposed around the outermost edge of the fuel electrode and fuel diffusion layer rather than on the inside surface. The component around the outermost edge of the fuel electrode of Ruhl is a peripheral porous protective band 15 for providing partial protection to the anode from oxygen at the outside of the fuel cell (col. 4, lines 23-28). Moreover, this Ruhl ‘955 embodiment with two seals employs forced flow, rather than gaseous diffusion, such as in the system of the present invention.

In regards to the second embodiment of Ruhl ‘955, the anode 4 is a fully unsealed layer, as is clearly depicted in Fig. 4. This is unlike the present invention which includes a seal disposed around the outermost side of the fuel electrode and fuel diffusion layer.

Moreover, the embodiment of Ruhl '955 with just one seal per cell (sealing the cathode, item 7 in Figs. 1 and 4) includes forced flow in regards to the fuel electrode in order to obtain mass transport, rather than gaseous diffusion as in the invention of the present application. Thus, it is clear that every feature of the present invention is not taught or disclosed by Ruhl '955.

The applicant further submits that one skilled in the art would not have been motivated to modify the teaching of Ruhl '955 to incorporate a non-porous seal around the anode (as in the present invention) since this would render the device of Ruhl '955 unsatisfactory for its intended purpose (for both embodiments, as discussed below). Again, Ruhl '955 discloses two embodiments (Figs. 1 and 4). The embodiment with two seals (one on the inside surface of the cathode and one on the inside surface of the anode) in conjunction with the oxygen-porous band 15 (shown in Fig. 1) employs forced flow, rather than gaseous diffusion in the case of the present invention. The embodiment of Ruhl '955 with just one seal per cell (sealing the cathode only, item 7 in Figs. 1 and 4) in conjunction with the oxygen-porous band 15 (shown in Fig. 4) employs forced flow in regards to the fuel electrode, rather than gaseous diffusion, in order to obtain mass transport.

The invention of the present application employs gaseous diffusion instead of forced flow. With a forced flow type of assembly, it is necessary that fuel exit the system via the anode. In other words, placing a non-porous seal around the anode of Ruhl '955 instead of the porous barrier would prevent fuel from properly exiting the assembly, thereby rendering the system completely inoperable. One skilled in the art would not have

been motivated to modify the oxygen-porous band 15 of the system of Ruhl '955 to be non-porous in order to arrive at the present invention for the simple fact that such a modification would render the Ruhl '955 system unsatisfactory for its intended purpose and therefore inoperable.

Additionally, there would not have been motivation for one skilled in the art to have modified the teaching of Ruhl '955 to incorporate this feature as Ruhl '955 discloses that it is a "desirable" feature to allow "partial protection" of the anode from oxygen, which clearly teaches away from the present invention. As explained above, it is desirable in Ruhl '955 to provide a protective band around the anode (i.e., on the outside of the anode) that is porous to oxygen and allows the retarded infiltration of oxygen (emphasis added) therethrough, thereby allowing oxygen gas to reach the anode at a retarded infiltration rate while providing a tubular gasket or seal 8 disposed between the separator and the electrolyte to form a substantially gas-tight seal at the inside surface of tube 14 (emphasis added), (col. 3, lines 33-34 & Fig. 1). The second embodiment of Ruhl '955 (shown in Fig. 4) discloses the anode 4 as being an unsealed layer on its inside surface while maintaining the oxygen-porous band 15 around the outside of the anode 14.

The Applicants further respectfully submit that one skilled in the art would have no motivation for combining the teachings of Isono, et al. with Ruhl since such a combination would also teach away from the present invention.

As noted by the Examiner, Ruhl '955 fails to disclose the specific tapered gas diffusion layer. Isono, et al., however, is not directed to a fuel cell having such a configuration. Isono, et al. discloses a fuel cell including a cell that is formed by



sandwiching solid polymer member between an anode and a cathode that generates electricity with stability and high performance by evenly moistening the solid polymer membrane (Abstract). The invention of Isono, et al. disposes a layer on the cathode catalyst layer so as to face the oxidizer channels, the layer being conductive and gas-permeable, water permeability of which is set to be lower in an area closer to an entrance for the oxidizer than in an area closer to an exit for the oxidizer. Here, the water permeability indicates the amount of water that moves through a unit area of a layer when the water concentration on one side of the layer is different from the water concentration on the other side. More amount of water moves through the layer, higher the water permeability. When the layer in which the water permeability has been adjusted is formed between the cathode catalyst layer and the oxidizer channels in this manner, the tendency that the amount of water evaporating from the solid polymer membrane is larger at the entrance for oxidizer gas than at the exit can be repressed. As a result, the solid polymer membrane can be evenly moistened. (Isono, et al., col. 2, lines 35-53).

The Examiner points out that Isono, et al. discloses a tapered diffusion layer where the reference states:

“The gas diffusivity is adjusted by changing the thickness and the ratio of pores of the gas diffusion layer. More specifically, the gas diffusivity is set relatively small by setting the ratio of pores small or the thickness large in the entrance part 211. On the other hand, the gas diffusivity is set relatively large by setting the ratio of pores large or the thickness small in the exit part 212.” (col. 2, lines 11-18)

However, Isono, et al. discloses that such a configuration causes the solid polymer

membrane to be overly moist at the exit, so that high electricity generation performance cannot be obtained (col. 1, lines 61-63). Isono, et al. further teach that in this case, the oxidizer is not evenly distributed across the cathodes and the concentration polarization is large in the electrode reaction, so that the power output is lowered. This is [a] problematic phenomenon. (col. 2, lines 21-25) (Emphasis added).

Isono, et al. clearly discourages a configuration whereby the diffusion layer has a relatively large thickness towards one end and a relatively small thickness towards the other end, or where the ratio of pores is small at one end and large at the other end. In other words, Isono, et al. sought to solve the issue at hand therein by avoiding a configuration having “tapered” diffusion layer(s). The Applicants respectfully submit that one skilled in the art would therefore not be motivated to adopt such a configuration in the structure of Ruhl in order to obtain the present invention since such a configuration would cause the disadvantageous situation set forth above, in turn causing the fuel cell stack to be inoperable for its intended purpose, or at least causing the fuel cell stack to function significantly less efficiently.

On the other hand, the fuel cell stack assembly of the present invention provides a configuration whereby the fuel diffusion layer and the oxygen diffusion layer include a tapered configuration while avoiding the issue set forth in the prior art. In fact, the fuel cell stack assembly of the present invention provides a configuration which is more functionally efficient and more cost-effective than the known prior art configurations. For example, the present invention allows the fuel electrode annular seals and oxygen electrode annular seals to have thicknesses which are about 10% than those of

conventional seals used in a comparatively sized fuel cell with comparable operating conditions. For example, a standard fuel cell having standard dimensions would typically include the seals at a thickness of about 1-2 mm each. The same cell, but having the configuration of the present invention, would have the seals at about 0.1-0.2 mm thick (see, for example, paragraph [000050] of the present specification).

In addition to the above, one would not rely on the combination of teachings to arrive at the present invention for the following reasons. The technology described by Isono, et al. is a polymer fuel cell system. On the other hand, the claims of the present application specifically refer to a high temperature solid oxide based fuel cell / electrolyzer system. The respective types of configurations are significantly different, in particular in their respective practical implementation.

In the case of the polymer system of Isono, et al. (as well as polymer fuel cell systems in general), water is both a byproduct and a necessary component of the electrolyte operation. Hydrogen is conducted as a hydronium ion ( $\text{H}_3\text{O}^+$ , or  $\text{H}_2\text{O}^+\text{H}^+$ ) across a hydrated polymer membrane and therefore must be recycled as a rate limiting step for operation. Isono, et. al. correctly teach that control of hydration is critical for successful operation and that limiting water access is a means of controlling operation to ensure uniformity. For example, in claim 4 of Isono, et al., the reference recites "...a content of the water repellent in the area closer to the entrance for the oxidizer is set to be higher than the content of the water repellent in the area closer to the exit..." In all cases, the references to "diffusion" and "water" in Isono, et al. refer to the short-range electrochemical reaction areas very near the electrolyte interface. In the polymer fuel cell,

control of the hydration is control of the reaction.

In the high temperature fuel cell / electrolyzer systems, water is either a byproduct of operation (i.e., in fuel cell mode) or a source of reactant (i.e., in electrolysis mode). However, in no instance is water transported across the electrolyte. Moreover, the distance over which the bulk diffusion occurs is in order of magnitude different in distance compared to the short-range diffusion taught by Isono, et al. For the preferred modes of operation of the present invention, the concentration of water is not a rate limiting or controlling factor. The control is established by the voltage / current characteristics of the cell and the external controlling electronics, and not the intrinsic concentration of water as taught by Isono, et al. It would be clear to one skilled in the art that these are significantly different concepts, deriving from dramatically different methods of operation between the polymer and solid oxide fuel cell system.

The tapering of the cell geometry, as taught in the present application, increases the net production or consumption of the reactants per unit of electrical power (i.e., to increase efficiency) by optimizing the presentation of the electrolyte surface to the internal plenum and external reactant manifold. It is respectfully submitted that this particular approach would not be rendered obvious even if one skilled in the art were to consider the teachings of Isono, et al. with those of Ruhl, the former not being applicable to solid oxide electrolyte systems.

In light of the above arguments, it is respectfully submitted that the application defined in the claims is patentably distinguishable over the prior art under 35 U.S.C. 103(a). Based on the aforementioned differences, each and every element of the presently

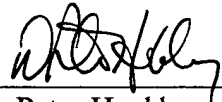
claimed invention are not set forth in the Ruhl, even when taken in view of Isono, et al., nor is there any motivation to modify the teaching of the Ruhl to include any teaching of Isono, et al.

### **Conclusion**

For the foregoing reasons, it is believed that the present application as amended is in condition for allowance, and such action is earnestly solicited. The Examiner is invited to call the undersigned if there are any remaining issues to be discussed which could expedite the prosecution of the present application.

Respectfully submitted,

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